

Form 2H-4 Calculation of Replacement Velocity Values for a Method 1 Equal-Area Sector Closest to the Stack Wall for a 16-Point Method 1 Traverse, Using a Complete Traverse1st Probe Type/ID/Pts. Sampled: Type S Straight-up/S-13/A11Tester(s): Test Team III2nd Probe Type/ID/Pts. Sampled: _____Affiliation: Contractor IIIEntry Port ID (e.g., A, B, C, or D): A

1. Diameter of the stack or duct (ft)	24		Radius, r , of the stack or duct (in.) (= diameter \times 6)	144			
2. Location (column A), measured and decay velocities (columns B and C), and volumetric flow (column G) associated with each successive wall effects traverse point.							
(A)	(B)	(C)	(D)		(E)	(F)	(G)
Distance (d) from Wall	Measured Velocity (v_d) at Distance d	Decay Velocity (v_{dec})	Intermediate Calculations			Area of Sub-sector (A_d)	Volumetric Flow in Sub-sector (Q_d)
		$\frac{v_{d-1} + v_d}{2}$	$\frac{1}{4}\pi[r-d+1]^2$	$\frac{1}{4}\pi[r-d]^2$		(Col. D - Col. E)	(Col. C \times Col. F)
		Note: $v_0 = 0$					
(in.)	(ft/sec)	(ft/sec)	(in. ²)	(in. ²)		(in. ²)	(ft-in. ³ /sec)
$d = 1$	51.71 NM	25.85	16,286.00	16,060.59		225.41	5,827.47
$d = 2$	51.71 NM	51.71	16,060.59	15,836.76		223.84	11,573.72
$d = 3$	51.71	51.71	15,836.76	15,614.49		222.27	11,492.51
$d = 4$	62.26	56.98	15,614.49	15,393.79		220.70	12,576.24
$d = 5$	67.16	64.71	15,393.79	15,174.67		219.13	14,179.40
$d = 6$	69.44	68.30	15,174.67	14,957.11		217.56	14,858.32
$d = 7$	72.63	71.03	14,957.11	14,741.13		215.98	15,341.75
$d = 8$	71.37	72.00	14,741.13	14,526.71		214.41	15,437.01
$d = 9$	74.37	72.87	14,526.71	14,313.87		212.84	15,510.03
$d = 10$	75.80	75.08	14,313.87	14,102.60		211.27	15,863.30
$d = 11$	77.15	76.47	14,102.60	13,892.90		209.70	16,035.93
$d_{last} = 12$	78.58	77.86	13,892.90	13,684.77		208.13	16,205.92
3. Total volumetric flow for all sub-sectors located between stack wall and d_{last} (total Col. G).							164,901.59
4. Volumetric flow for remainder of the Method 1 equal-area sector.							
a. Velocity measurement at distance d_{rem} from stack wall (v_{drem}). (If $d_{rem} - d_{last} < \frac{1}{2}$ in., then no measurement at d_{rem} is necessary. Enter the velocity at d_{last} on this line.)							78.51
b. Total area in remainder of Method 1 equal-area segment (A_{drem}). Subtract $\frac{3}{16}\pi(r)^2$ from last entry in item 2, column E, and enter the result on this line.							1,470.26
c. Multiply values on lines 4a and 4b. (Q_{drem})							115,430.44
5. Wall effects-adjusted velocity in the Method 1 equal-area sector.							
a. Add the values on lines 3 and 4c. (Q_T)							280,332.03
b. Divide line 5a by $\frac{1}{16}\pi(r)^2$. The resulting value is one of four "replacement" point velocity values adjusted for wall effects, \hat{v}_{eL} , as derived in Equation 2H-16.							68.85
6. Substitute the value shown in 5b for the unadjusted velocity value in the Method 1 sector. (See Eq. 2H-18.)							

METHOD 3—GAS ANALYSIS FOR THE DETERMINATION OF DRY MOLECULAR WEIGHT

NOTE: This method does not include all of the specifications (e.g., equipment and supplies) and procedures (e.g., sampling) essential to its performance. Some material is in-

corporated by reference from other methods in this part. Therefore, to obtain reliable results, persons using this method should also have a thorough knowledge of Method 1.

1.0 Scope and Application**1.1 Analytes.**

Analytes	CAS No.	Sensitivity
Oxygen (O ₂)	7782-44-7	2,000 ppmv.
Nitrogen (N ₂)	7727-37-9	N/A.
Carbon dioxide (CO ₂)	124-38-9	2,000 ppmv.
Carbon monoxide (CO)	630-08-0	N/A.

1.2 Applicability. This method is applicable for the determination of CO₂ and O₂ concentrations and dry molecular weight of a sample from an effluent gas stream of a fossil-fuel combustion process or other process.

1.3 Other methods, as well as modifications to the procedure described herein, are also applicable for all of the above determinations. Examples of specific methods and modifications include: (1) A multi-point grab sampling method using an Orsat analyzer to analyze the individual grab sample obtained at each point; (2) a method for measuring either CO₂ or O₂ and using stoichiometric calculations to determine dry molecular weight; and (3) assigning a value of 30.0 for dry molecular weight, in lieu of actual measurements, for processes burning natural gas, coal, or oil. These methods and modifications may be used, but are subject to the approval of the Administrator. The method may also be applicable to other processes where it has been determined that compounds other than CO₂, O₂, carbon monoxide (CO), and nitrogen (N₂) are not present in concentrations sufficient to affect the results.

1.4 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 A gas sample is extracted from a stack by one of the following methods: (1) single-point, grab sampling; (2) single-point, integrated sampling; or (3) multi-point, integrated sampling. The gas sample is analyzed for percent CO₂ and percent O₂. For dry molecular weight determination, either an Orsat or a Fyrite analyzer may be used for the analysis.

3.0 Definitions [Reserved]

4.0 Interferences

4.1 Several compounds can interfere, to varying degrees, with the results of Orsat or Fyrite analyses. Compounds that interfere with CO₂ concentration measurement include acid gases (*e.g.*, sulfur dioxide, hydrogen chloride); compounds that interfere with O₂ concentration measurement include unsaturated hydrocarbons (*e.g.*, acetone, acetylene), nitrous oxide, and ammonia. Ammonia reacts chemically with the O₂ absorbing solution, and when present in the efflu-

ent gas stream must be removed before analysis.

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method.

5.2 Corrosive Reagents.

5.2.1 A typical Orsat analyzer requires four reagents: a gas-confining solution, CO₂ absorbent, O₂ absorbent, and CO absorbent. These reagents may contain potassium hydroxide, sodium hydroxide, cuprous chloride, cuprous sulfate, alkaline pyrogallol acid, and/or chromous chloride. Follow manufacturer's operating instructions and observe all warning labels for reagent use.

5.2.2 A typical Fyrite analyzer contains zinc chloride, hydrochloric acid, and either potassium hydroxide or chromous chloride. Follow manufacturer's operating instructions and observe all warning labels for reagent use.

6.0 Equipment and Supplies

NOTE: As an alternative to the sampling apparatus and systems described herein, other sampling systems (*e.g.*, liquid displacement) may be used, provided such systems are capable of obtaining a representative sample and maintaining a constant sampling rate, and are, otherwise, capable of yielding acceptable results. Use of such systems is subject to the approval of the Administrator.

6.1 Grab Sampling (See Figure 3-1).

6.1.1 Probe. Stainless steel or borosilicate glass tubing equipped with an in-stack or out-of-stack filter to remove particulate matter (a plug of glass wool is satisfactory for this purpose). Any other materials, resistant to temperature at sampling conditions and inert to all components of the gas stream, may be used for the probe. Examples of such materials may include aluminum, copper, quartz glass, and Teflon.

6.1.2 Pump. A one-way squeeze bulb, or equivalent, to transport the gas sample to the analyzer.

6.2 Integrated Sampling (Figure 3-2).

6.2.1 Probe. Same as in Section 6.1.1.